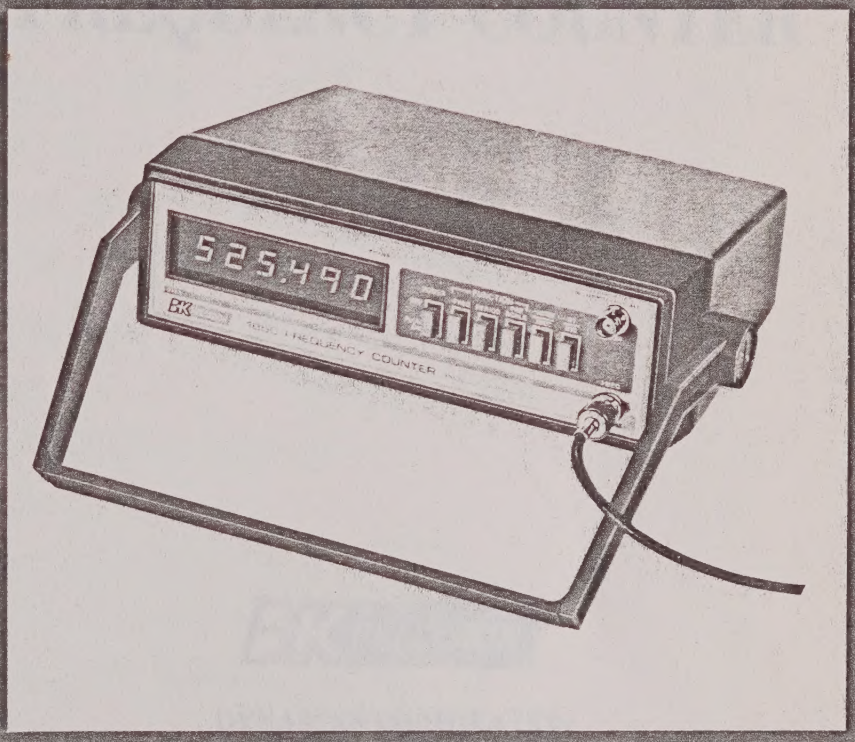
INSTRUCTION MANUAL

B+K PRECISION 1850

520 MHz FREQUENCY COUNTER



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INSTRUCTION MANUAL
FOR
MODEL 1850

520 MHz
FREQUENCY COUNTER

B+K PRECISION

DYNASCAN CORPORATION
6460 West Cortland Street
Chicago, Illinois 60635

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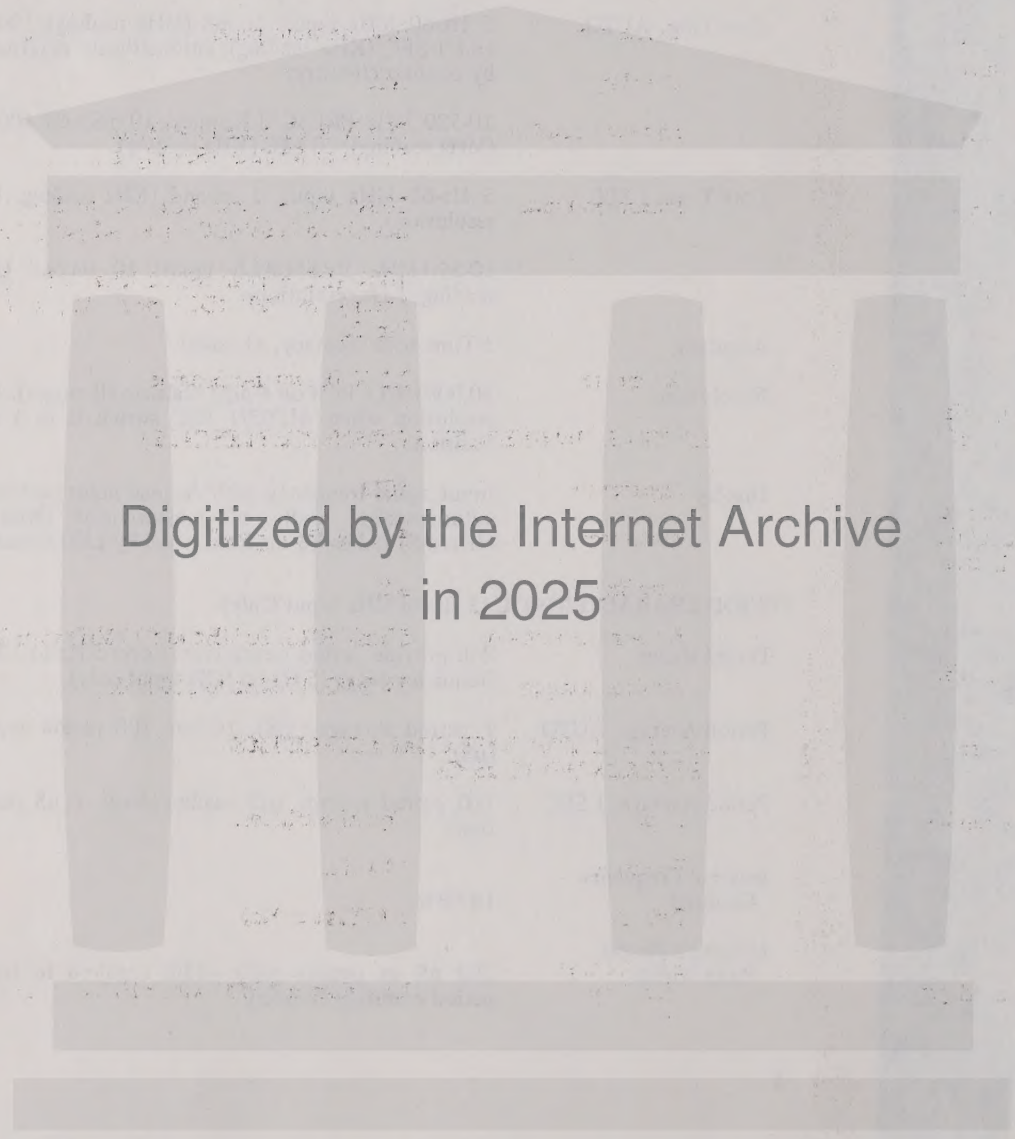
SPECIFICATIONS

FREQUENCY CHARACTERISTICS

Range	5 Hz-60 MHz input: AUTO/1 SEC switch selects AUTO or KHz display reading. 10-520 MHz PRESCALE input: AUTO/1 SEC switch selects AUTO or KHz display reading.
Gate Time, AUTO	5 Hz-60 MHz input: 10 mS (MHz reading), 100 mS and 1 SEC (KHz reading), automatically determined by counter circuitry. 10-520 MHz PRESCALE input: 10 mS and 100 mS (MHz reading), 10 SEC (KHz reading).
Gate Time, 1 SEC	5 Hz-60 MHz input: 1 second (KHz reading, 1 Hz resolution). 10-520 MHz PRESCALE input: 10 second (KHz reading, 1 Hz resolution).
Accuracy	± Time base accuracy, ±1 count.
Resolution	±0.0001% (1 PPM on 6-digit scale on all ranges). 1 Hz resolution when AUTO/1 SEC switch is in 1 SEC position.
Display	Input signal frequency with decimal point positioned automatically. Units of measurement (KHz/μS, MHz/mS) indicated on front panel by LED indicator.

PERIOD CHARACTERISTIC (5 Hz-60 MHz Input Only)

Period Range	Will provide period measurement over 5 Hz to 1 MHz frequency range (5 Hz-60 MHz input only).
Period Average, AUTO	1 period average (mS), 10 and 100 period average (μS).
Period Average, 1 SEC	100 period average (μS reading with 1 nS resolution).
Internal Frequency Counted	10 MHz.
Minimum Period Pulse Width	200 nS or greater pulse width required to trigger period counting circuitry.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Accuracy	$\frac{\text{Trigger Uncertainty} \pm \text{Time Base Accuracy}}{\text{Periods Average}}$ ±1 LSD
Display	Input signal period with automatically positioned decimal point. Units of measurement (mSEC or μSEC) displayed on front panel by LED indicators.
Overrange	Flashing OVER indicator.

INPUT CHARACTERISTIC (5 Hz-60 MHz Input)

Impedance	1 megohm resistance, shunted by 25 pF capacitance.
Connector	BNC on front panel.
Coupling	AC.
Sinewave Sensivity	30 mV RMS, 5 Hz to 40 MHz. 50 mV at 60 MHz. (See Fig. 1.)
Maximum Input	200V (DC + peak AC), DC to 500 Hz, decreasing linearly to 100V (DC + peak AC) at 1 KHz. 100V (DC + peak AC), 1 KHz to 5 MHz, decreasing linearly to 30V (DC + peak AC) at 60 MHz. (See Fig. 2.)
Attenuator	X1/X10, switch-selectable.

INPUT CHARACTERISTICS (10-520 MHz PRESCALE)

Impedance	50Ω.
Connector	BNC on front panel.
Coupling	AC.
Sinewave Sensitivity	50 mV RMS, 10 MHz to 520 MHz with 50Ω.
Maximum Input	5V RMS, 10 MHz to 520 MHz.

INTERNAL TIME BASE CHARACTERISTICS (REFERENCED TO 25°C)

Type	Crystal oscillator.
Frequency	10 MHz.
Setability	±.1 PPM (±1 Hz).
Line Voltage Stability	Less than ±.1 PPM with ±10% line voltage variation.

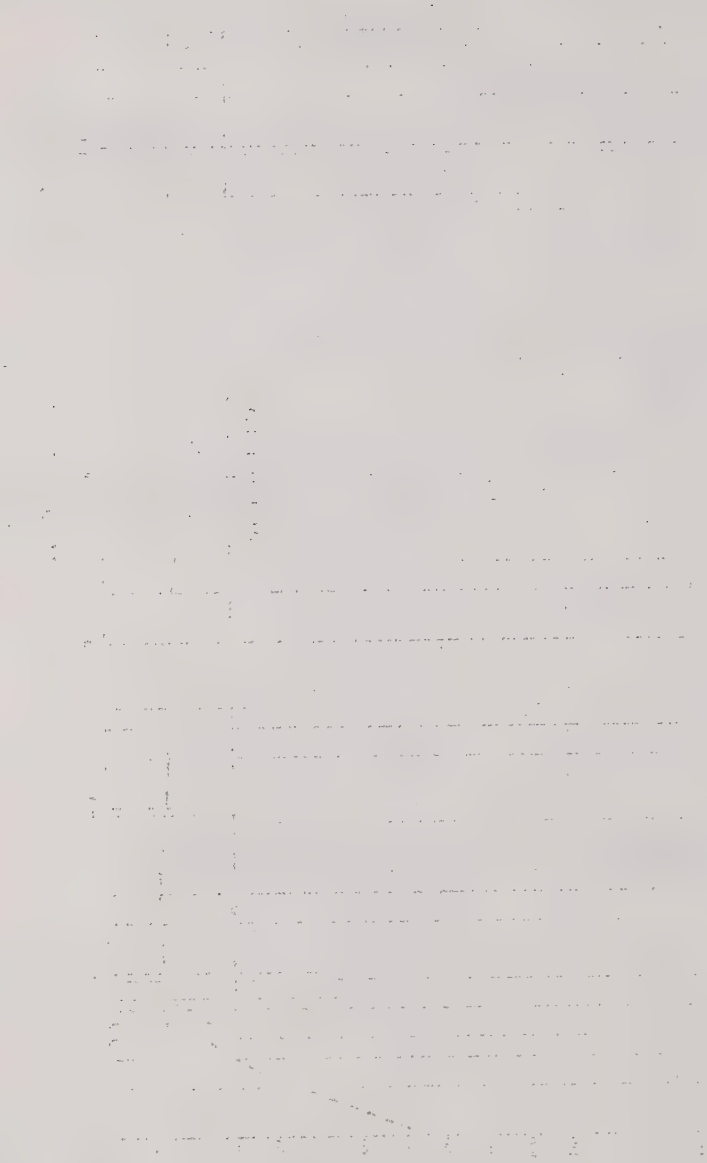
Temperature Stability	Less than ±0.0001% (±1 PPM from 0°C to 50°C ambient).
Maximum Aging Rate	±1 PPM/YR.
Output (accessible at rear)	TTL compatible square wave, capable of driving equivalent of 5 TTL loads.

DISPLAY CHARACTERISTICS

Visual Display	6 digits with overflow. KHz/μS, MHz/mS indicator. Leading zero blanking, decimal point automatically positioned.
Overrange Indication	Flashing LED indicates that counter range is exceeded.
Display Time	Fixed at 200 mS plus gate interval.

GENERAL

Power Requirements	105V-130V or 210V-260V, with internal transformer jumpers, 50/60 Hz AC. 11-16V DC automotive battery (negative ground) with accessory power cable (provided with unit).
Dimensions (HWD)	3.25 x 11.57 x 7.5″. (8.25 x 29.4 x 19 cm.)
Weight	3.2 lbs. (1.5 Kg.)
Handle	Four positions, integral part of case.
Accessories Supplied	BNC-to-clip lead test cable. DC power cable with cigarette lighter plug.
Optional Accessories Available	Model LC-50 Carrying Case. Model SA-10 Signal Tap. Model PR-32 Demodulator Probe. Model PR-36 10:1 and 1:1 Compensated Oscilloscope Probe. Model PR-37 10:1 and 1:1 Compensated Oscilloscope Probe.



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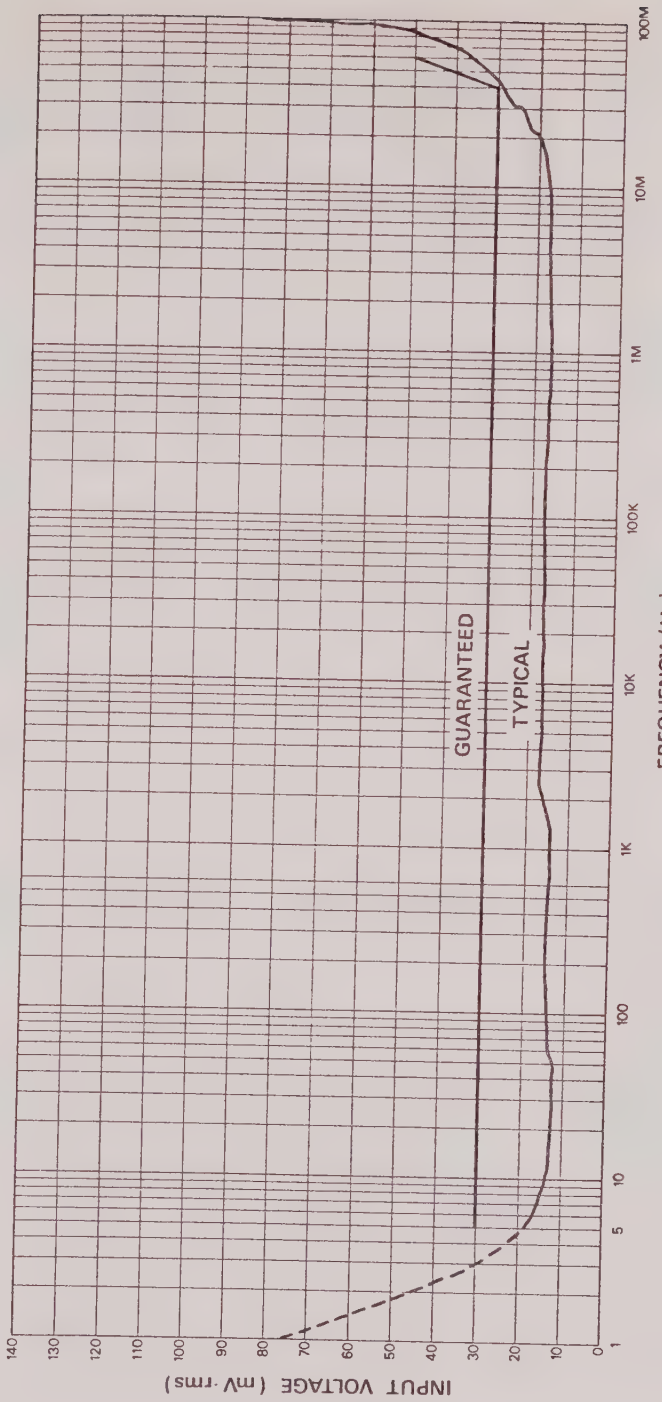

Fig. 1. Input Sensitivity Curve.

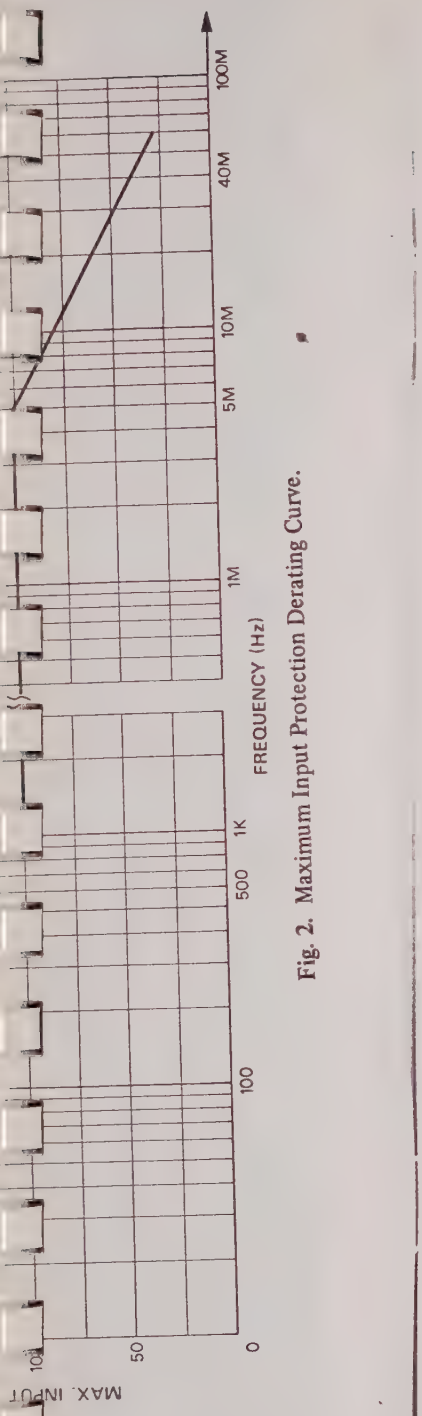

Fig. 2. Maximum Input Protection Derating Curve.

OPERATION

CONTROLS AND FEATURES (See Fig. 3 and 4)

1. **POWER.** When this pushbutton is depressed, primary power is applied to the frequency counter. To turn off the unit, depress power switch again. The switch is in the secondary circuit of the transformer.

2. **FREQ** (Input to 5 Hz-60 MHz Jack). Selects one of the two frequency-counting functions of the counter. When this pushbutton is depressed, and with a signal input to 5 Hz-60 MHz jack (10), the counter is capable of counting any frequency between 5 Hz and 60 MHz. The unit of measurement of the input frequency is indicated by the KHz/μS or MHz/mS LED and KHz or MHz, as appropriate.

3. **PERIOD** (Measured with Input to 5 Hz-60 MHz Jack Only). Depress this pushbutton when it is desired to determine the period of one cycle of the signal under test. When the Model 1850 measures low frequencies directly, the last count is uncertain. Therefore, when it is necessary to determine a low frequency with a higher degree of accuracy, use of the PERIOD function is desirable. The last count is uncertain in the PERIOD function also; however, the percentage of error is smaller. The KHz/μS or MHz/mS LED indicates the time units of the period of the cycle in microseconds or milliseconds, as appropriate. Frequency is determined by calculating the reciprocal of the measured period. Refer to APPENDIX frequency tables for popular low frequencies and their corresponding PERIODS.

4. **PRESCALE** (Used with Input to 10-520 MHz Input Jack). This input is convenient for measuring frequencies in signal transmission and communications systems. A built-in 50-ohm termination is provided to minimize measurement errors resulting from impedance mismatches and the resulting standing waves, particularly in VHF and UHF measurements. The X1/X10 attenuator function does not apply with input to the 10-520 MHz PRESCALE jack. The maximum allowable input signal level to this jack is 5V RMS.

5. **AUTO/1 SEC** (100 Period Average). When this switch is in the AUTO (out) position, the gate length is automatically controlled by the frequency under test. In the PERIOD function, the 1, 10 or 100 period average is automatically selected. The AUTO position will always select a range that will try to fill all six digits without overranging. Pushing this switch in (1 SEC), causes the counter to produce a constant gate length of one second (or 10 seconds in PRE-SCALE). This allows the counter to display the least significant digit. When the PERIOD function is in use and the AUTO/1 SEC switch is depressed, the counter displays a 100 period average.

6. **X1/X10** (For 5 Hz-60 MHz Input Only). This switch controls the built-in attenuator in the counter. If the switch is in the out position (X1), the input is applied to the counter circuitry without attenuation. Pressing the switch in (X10), switches a X10 attenuator in series with the input signal. The attenuator limiter prevents the counter logic circuitry from miscounting when noisy or improperly terminated high-amplitude signals are applied to the counter. Refer to Fig. 2 for maximum allowable input voltages. This feature is not used in the PRESCALE mode.

7. **KHz/μS Indicator.** If this indicator is illuminated, it denotes that the frequency displayed is in kilohertz or the period is in microseconds.

8. **MHz/mS Indicator.** If this indicator is illuminated, the frequency displayed is in megahertz, or the period is in milliseconds.

9. **OVER.** Flashes rapidly when the range of the display is exceeded.

10. **INPUT JACK** (5 Hz-60 MHz). This is a female BNC connector terminated in a 1-megohm input impedance. This allows the use of ÷10 frequency-compensated scope probe to reduce loading on the source of the signal under test. If a compensated probe is not used, high-frequency measurement sensitivity is limited.

11. **INPUT JACK (10-520 MHz PRESCALE).** This is a female BNC connector terminated in a 50Ω input impedance. This allows for good impedance matches and noise immunity in 50Ω systems.

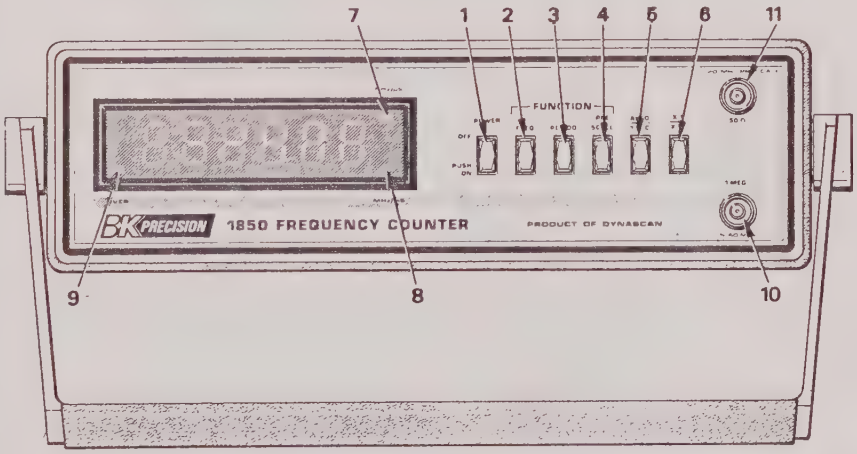

Fig. 3. Model 1850 Front Panel.

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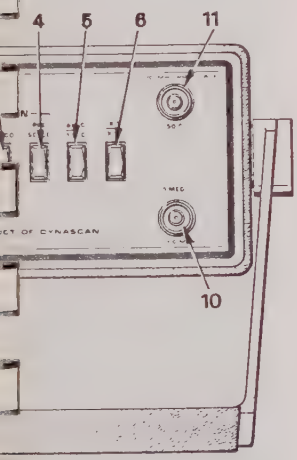

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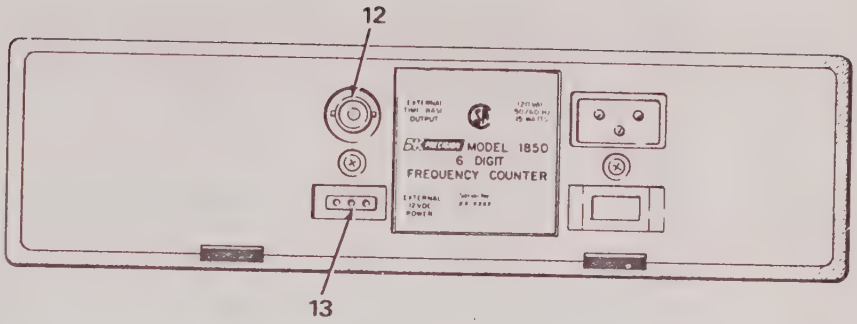

Fig. 4. Model 1850 Rear Panel.

12. **EXTERNAL TIME BASE OUTPUT Jack** (At Rear of Instrument). This female BNC jack provides a convenient means of connecting the internal time base to other equipment.

13. **DC POWER INPUT** (At Rear of Instrument). This is used with the DC power cord provided to operate the Model 1850 counter from the cigarette lighter socket of a vehicle. This can be used only in negative ground systems.

INTERPRETATION OF DISPLAY

Fig. 5 illustrates an example of a display of numerals on the front panel of the counter. As indicated in the figure, the numeral "6", at the extreme left of the display, is the most significant digit; "1" is the least significant digit.

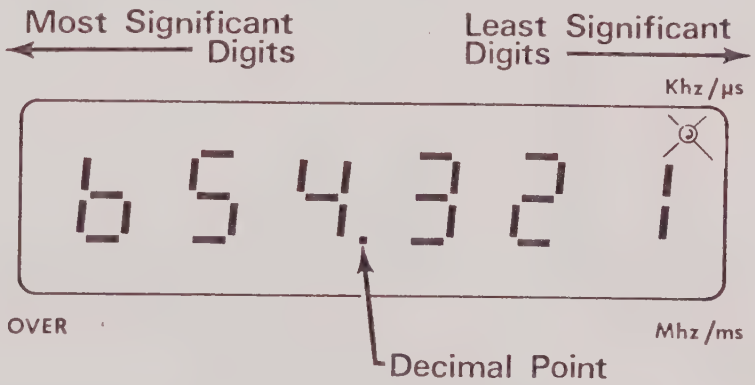

Fig. 5.

The three LED indicators, KHz/µS, MHz/mS and OVER, are also shown in the figure. In this example, the KHz/µS indicator is lit, as indicated by the small circle.

If the display is as shown in Fig. 5 when the counter is operating in the FREQ function, the frequency of the signal under test is 654.321 KHz, or 654,321 Hz. If the PERIOD function is in use and the display is as shown in Fig. 5, the time required for one cycle to occur is 654.321 microseconds (100 period average).

Whenever the PERIOD function is in use, always interpret the counter display in microseconds or milliseconds, whichever is appropriate. The PERIOD function is used with input to the 5 Hz-60 MHz jack only.

Fig. 6 illustrates a display of .321 KHz (321 Hz). Note that the decimal point remains in the same position as in Fig. 5, and that the three LED units to the left of the decimal point are blank.

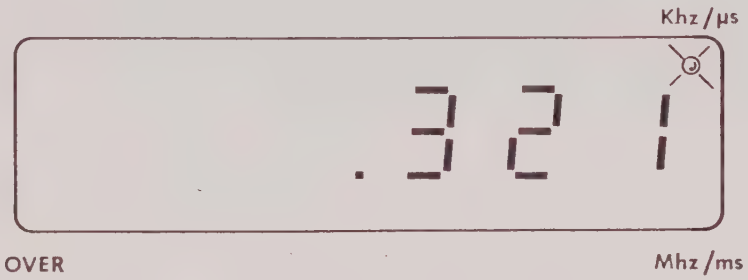

Fig. 6.

A frequency of less than 100 Hz is displayed as shown in Fig. 7. The counter is displaying .021 KHz (21 Hz).

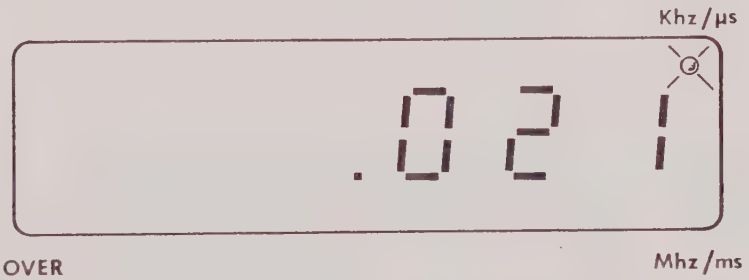

Fig. 7.

All the digits to the left of the decimal point are blank. As the number of digits displayed by the counter decreases, the accuracy of the measurement also decreases. This is because the last count is uncertain. Therefore, the frequency displayed may actually be .020, .021, or .022 KHz.

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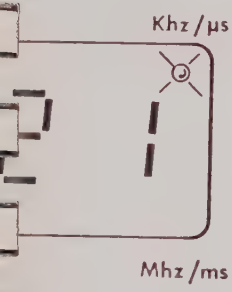

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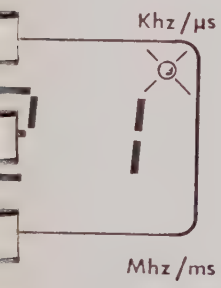

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The accuracy of the counter display is enhanced at these low frequencies when the PERIOD function is used. For example, when the counter is displaying .200 KHz (200 Hz), the actual input frequency may be 199 Hz, 200 Hz or 201 Hz. This is because the last count is uncertain. As a result, the display may be in error by 0.5%.

In many situations a higher degree of accuracy may be required. When the PERIOD function is activated, the counter displays the time required for one cycle of the input frequency to occur. One cycle of 200 Hz occurs in 5000 μSEC. This is displayed by the counter as 5000.00. The last count is uncertain in this display also.

However, the uncertainty of error is only .0002%. As a result, the actual period could be 4999.99 μSEC, 5000.00 μSEC, or 5000.01 μSEC. By using the formula, F=1/P, the frequency that corresponds to each period can be calculated. If the period is 4999.99 μSEC, its corresponding frequency is 200.004 Hz; if the period is 5000.01 μSEC; its corresponding frequency 199.996 Hz. Consequently, it can be concluded that the percentage of error in the PERIOD function is much smaller than in the FREQ function.

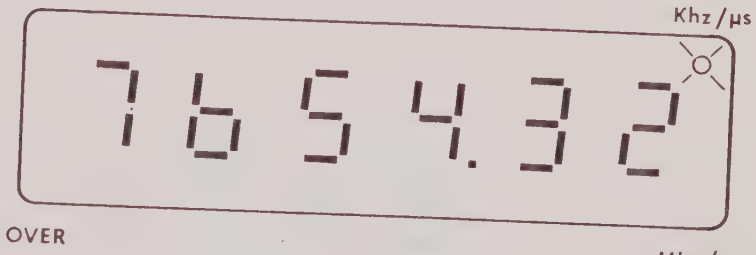


Fig. 8.

Fig. 8 illustrates a display of 7654.32 KHz with the AUTO/1 SEC switch in the AUTO (out) position. As indicated by the position of the decimal point, the least significant digit displayed is the tens digit. As a result, the reading may be in error by as much as 10 Hz (.01 μSEC in the PERIOD function) because of the uncertainty of the last digit.

If the AUTO/1 SEC switch is set to the 1 SEC (in) position while the same input frequency is applied, the display could appear as shown in Fig. 9. In this display, the least significant digit shown is the units (ones) digit as indicated by the decimal point position. Consequently, the accuracy of this measurement is improved because the uncertainty of the last digit is 1 Hz instead of 10 Hz. However, note the most significant digit (7) in Fig. 8 is not displayed in Fig. 9. This is indicated by the OVER indicator flashing on and off.

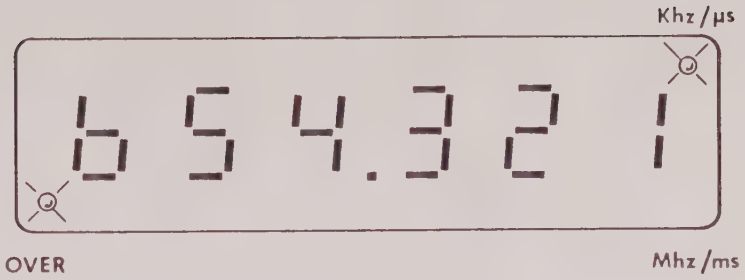


Fig. 9.

Maximum resolution to the nearest Hz (or nearest nanosecond in the PERIOD function) is obtained when the AUTO/1 SEC (100 period average) switch is set to the 1 SEC position. This is because the least significant digit is displayed. However, the most significant digit cannot be determined when the switch is in the 1 SEC (100 period average) position.

Therefore, it may be desirable to first read the counter with the AUTO/1 SEC switch in the AUTO position and then switch to the 1 SEC position and read the counter again.

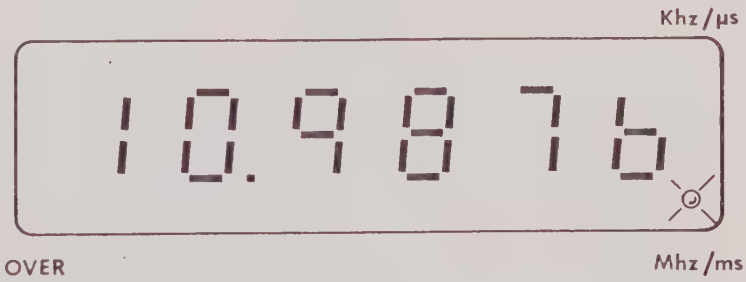


Fig. 10.

Fig. 10 illustrates a display of 10.9876 MHz (or 10.9876 mSEC in the PERIOD function) with the AUTO/1 SEC switch set to the AUTO (out) position. Notice that the two least significant digits are not displayed. However, the two most significant digits (1 and 0) are displayed and the OVER LED is not lit.

If it is desired to improve the resolution of the measurement shown in Fig. 10, set the AUTO/1 SEC switch to the 1 SEC (in) position. If the PERIOD function is in use, and the AUTO/1 SEC switch is in the 1 SEC position, the reading is a 100 period average.

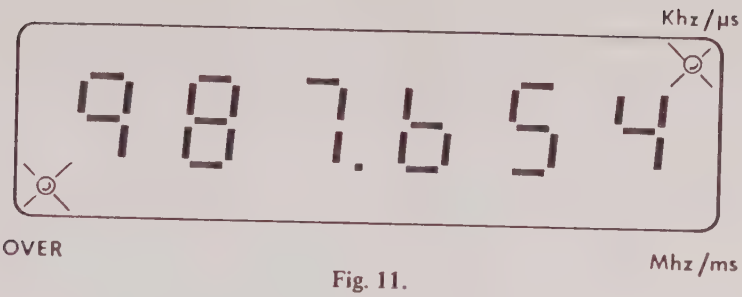


Fig. 11.

An example of how the display could appear is shown in Fig. 11. The two most significant digits are not displayed and the OVER LED is flashing to indicate that the frequency or period being measured is greater than that displayed.

The least significant digits of a frequency or period measurement may change as the display is observed. The amount of change is related to the stability of the signal source. If the output frequency of an LC oscillator is being measured, the counter display will probably change frequently. However, the output of a crystal oscillator is much more stable. Therefore, the counter display will be nearly constant.

HOW TO OPERATE THE MODEL 1850

CAUTION

Application of signals having voltage levels in excess of those listed in the SPECIFICATIONS in this manual may damage the counter. Therefore, before applying any signal to the counter input, always insure that the voltage of the input signal does not exceed the maximum allowable input listed in the SPECIFICATIONS. Note that the maximum allowable input level at the 10-520 MHz PRESCALE jack is 5V RMS at all frequencies. The X10 setting of the X1/X10 switch does NOT protect the input limiter circuitry against voltages in excess of those listed in the SPECIFICATIONS. Therefore, NEVER apply voltages whose peaks exceed the specified input ratings of the frequency counter. If necessary, connect an attenuator between the signal source and the counter input.

A. GENERAL

1. Standing waves are usually present on a transmission line that is not terminated in its characteristic impedance. These standing waves may cause damage to the signal source or produce inaccurate frequency measurements. Therefore, when measuring radio frequencies, terminate the transmission line connecting the counter to the signal source in the characteristic impedance of the signal source. For example, terminate

50-ohm coaxial cable into a 50-ohm resistive load. Use a DC blocking capacitor in situations where bias voltage or other DC voltages could be affected by the termination-resistor. For frequency measurements above 10 MHz, the 10-520 MHz input jack should be used when working in 50-ohm systems. An internal 50-ohm termination is provided at this jack.

2. When counting signals with amplitudes less than 300 mV RMS, a 10:1 frequency-compensated probe cannot be used, since less than 30 mV RMS signal is present at the counter input jack (see SPECIFICATIONS).

3. When counting low-frequency signals, it may be necessary to add a 10 K resistor in series between the signal source and the 1:1 probe or direct frequency counter input. This resistor will attenuate any high-frequency noise that may cause the counter to display an erratic count.

4. It is not necessary to use a line termination if a compensated high-impedance probe is used at the 5 Hz-60 MHz input jack. The following high-impedance, compensated signal probes are suitable for use with the Model 1850 counter and are available as options from **DYNASCAN**:

   B & K-PRECISION Model PR-36 10:1 and 1:1 compensated oscilloscope probe.

   B & K-PRECISION Model PR-37 10:1 and 1:1 compensated oscilloscope probe.

   The loading effect of the PR-36 probe is 1 megohm with 120 picofarads of shunt capacitance at the point of measurement, when used in the X1 mode. The loading effect is 10 megohms with 15 pF of shunt capacitance when used in the X10 mode. The loading effect of the PR-37 is 1 megohm and 60 pF direct and 10 megohms and 11 pF in the X10 mode.

5. If it is desired to assemble additional test cable, use 50-ohm coaxial cable, such as RG-58 A/U. The longer the test cable, the greater the amount of undesirable shunt capacitance the cable introduces at the point being measured. In addition, the effect of standing waves becomes more pronounced as the cable length approaches one-quarter wavelength of frequency being measured. This is especially true if the cable is not terminated in its characteristic impedance. Therefore, to keep shunt capacitance and standing waves within tolerable limits when using the 5 Hz-60 MHz input, it is recommended that the cable be no longer than 3 feet (90 cm). In 50-ohm systems the 50-ohm input impedance of the 10-520 MHz PRESCALE jack minimizes standing waves and reduces the restriction on lengths of connecting cables used.

B. FREQUENCY MEASUREMENTS

1. 5 Hz to 60 MHz.

   a. Turn on the power to the 1850 by fully depressing the POWER switch.

   b. Fully depress the FREQ pushbutton.

   c. Make sure the AUTO/1 SEC switch is in the AUTO (out) position.

   d. If necessary, set the X1/X10 switch to the X10 (in) position and/or add an external attenuator (refer to SPECIFICATIONS). The attenuator has no effect when PRESCALE function is selected and the 10-520 MHz input jack is used.

   e. Apply the signal frequency to be measured to the 5 Hz-60 MHz input jack.

   f. If it is desired to improve the resolution of the frequency count on the display, set the AUTO/1 SEC switch to the 1 SEC position by fully depressing the switch. For example, if a frequency of 10.654321 MHz is applied to the counter while the AUTO/1 SEC switch is in the AUTO (out) position, the counter will display 10.6543 MHz. However, after the AUTO/1 switch is set to 1 SEC (in) the counter will display 654.321 KHz while the OVER indicator flashes.

2. 10-520 MHz (PRESCALE).

   a. Fully depress the POWER switch.

   b. Depress the PRESCALE FUNCTION button.

   c. Connect the signal input to the 10-520 MHz PRESCALE jack.

CAUTION

The maximum input limit to this jack is 5V RMS maximum over the input frequency range. The X1/X10 attenuator function does not apply. The input impedance is 50 ohms.

   d. With the AUTO/1 SEC switch in the AUTO (out) position, the most significant digits will be displayed.

e. To obtain 1 Hz resolution, set the AUTO/1 SEC switch to the 1 SEC (in) position. The display is updated every 10 seconds when in this mode. The reading obtained indicates the average frequency over the 10-second interval. If a highly stable frequency source (crystal-controlled) is being monitored, the successive frequency counts will vary only slightly. If the frequency source is unstable, a significant frequency change will occur during the 10-second interval.

f. When making frequency adjustment in the 1 SEC mode, the adjustment should be made and then a minimum of two counts should be observed to determine the effect of the frequency adjustment.

C. PERIOD MEASUREMENTS

(Frequency range of 5 Hz to 1 MHz with Input to 5 Hz-60 MHz Jack Only)

1. Apply power to the counter.

2. Depress the PERIOD pushbutton switch fully.

3. Set the AUTO/1 SEC switch to AUTO (out).

4. If necessary set the X1/X10 switch to the X10 (in) position and/or add an external attenuator (refer to SPECIFICATIONS).

5. Apply the signal whose period is to be measured to the 5 Hz-60 MHz input jack.

6. The counter display will now indicate the number of milliseconds or microseconds required for one cycle.

7. If a higher degree of resolution at frequencies less than 1 KHz is desired, set the AUTO/1 SEC switch to the 1 SEC (100 period average) position.

   When measuring the period of a signal having a frequency less than 20 Hz, it may be necessary to wait for as long as 15 seconds before a usable reading is displayed.

8. The exact frequency can be determined by calculating the reciprocal of the measured period. Refer to APPENDIX for popular frequencies that have been already calculated.

D. EXTERNAL TIME BASE OUTPUT

This highly stable frequency is continuously available at a BNC output jack at the rear of the instrument. Refer to the APPLICATIONS section for possible uses. The output is a TTL compatible square wave capable of driving the equivalent of 5 TTL loads.

A. Radio Transmitter Frequency Measurement Using Signal Taps.

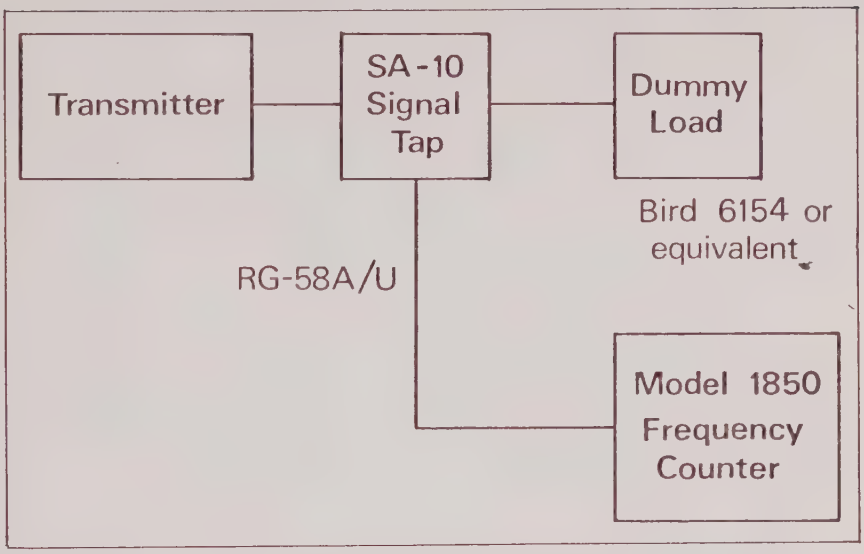


Fig. 12. Measuring transmitter frequency.

Fig. 12 illustrates a typical test setup for measuring the frequency of the RF output from the radio transmitter having an output power of 100 watts or less.

1. A 50-ohm termination, such as the BIRD 6154, may be used to terminate the output of the transmitter. However, if a termination of this type is not available, use a 50-ohm, non-inductive resistor as a dummy load. The power rating of the resistor must be adequate for the application.

2. The optional SA-10 Signal Tap protects the output stage of the transmitter against a severe mismatch. The signal tap also protects the counter input circuitry against excessive signal voltage. The upper frequency range of the SA-10 is limited to about 80 MHz.

B. Alternate Methods of Frequency Measurement.

Fig. 13 shows alternate methods of signal pick-up for frequency measurement.

1. The voltage divider of Fig. 13A can be used when there is access to the load resistor terminals. The dividing resistor (1K to 2K) is large compared to the 50-ohm load and causes negligible mismatch. The divider should be removed when frequency measurements are completed. The set-up is ideal for the 10-520 MHz input which has a built-in 50-ohm impedance.

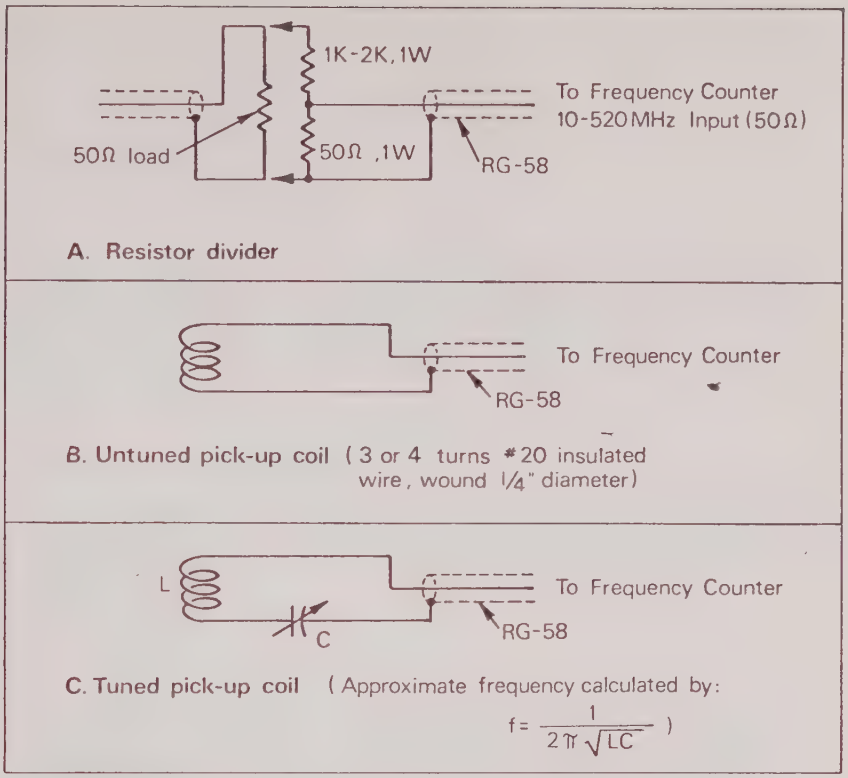


Fig. 13. Alternate Signal Pick-up Methods.

2. The untuned pick-up coil shown in Fig. 13B is ideal when a signal tap is not available or practical. The assembly is broadband and can be used with either frequency counter input.

3. The tunable pick-up coil of Fig. 13C provides means for selective measurement of frequency. This is convenient in high-noise areas or when several frequencies are present. This method can be used with either frequency counter input.

4. Another method (not shown) is to use a wide-band oscilloscope probe, such as the B & K-PRECISION PR-36 or PR-37 in the X10 mode. Because these probes are designed to be frequency-compensated with one-megohm oscilloscope inputs, they should only be used in the 5 Hz-60 MHz input jack which has a nominal one-megohm input impedance.

C. Amplitude-Modulated Signals.

A high percentage of amplitude modulation may cause the counter to display an erroneous frequency. This is because the carrier amplitude periodically

drops to near zero at high modulation levels. If this signal is applied through an attenuator to the counter, the carrier level at the counter will be even lower, and the counter will not count through the entire gate interval. To insure an accurate carrier frequency reading, remove the modulation during the frequency count.

D. Frequency-Modulated Signals.

When measuring frequency-modulated signals, an accurate carrier frequency count can be made with modulation applied because the counter averages the frequency counts. If the modulation is non-symmetrical, a count error may result, as the average count will not correspond to the carrier frequency. Always check the measurement with and without frequency modulation applied.

E. Measuring Amplitude-Modulation Frequencies.

If it is desired to measure the frequency of the modulation on an RF carrier, use a detector with a low pass filter or a demodulation probe such as the **B & K-PRECISION** PR-32. The probe can be connected directly to the 5 Hz-60 MHz jack.

F. Square Wave or Pulse Train Measurement.

False counts frequently occur when the frequency of square waves or a pulse train is measured, particularly when an unterminated input cable is used. The false counting is the result of over-shooting (ringing) in the unterminated input cable. Ringing can be eliminated if a damping resistor of the proper value is added in series with the transmission line. Refer to the APPENDIX for the formula needed to calculate the value of the damping resistor. If a short cable is used with a terminating resistor at the counter input, the results are almost invariable satisfactory. The value of the terminating resistor must match the output impedance of the signal source.

G. Uses of External Time Base Output (10 MHz)

1. The output can be used as a high-stability external time base input to one or more frequency counters.

2. As a high-stability clock source for digital work. the 1 PPM 10 MHz output can be divided to any convenient frequency using external circuitry.

3. As a frequency calibrator for frequency generators. The high harmonic content of the square-wave output can be used for frequency calibration at multiples and sub-multiplies of 10 MHz.

4. As a time-base calibrator for triggered sweep oscilloscopes.

THEORY OF OPERATION

When reading the following paragraphs, refer to the Model 1850 block diagram shown in Fig. 14. For complete and detailed maintenance and repair information, refer to Service Manual 494-059-9-001, available from B & K-PRECISION Service Department, 2815 W. Irving Park Road, Chicago, Illinois, 60618 for $5.00 prepaid.

Input Amplifier and Attenuator (5 Hz-60 MHz)

Consists of a wide-band amplifier and X10 attenuation circuit. The input is level-limited by clamping diodes and the FET, Q1, provides good sensitivity over the frequency range 5 HZ to 60 MHz. Switching transistors, Q2 and Q4 are turned on and off by the X1/X10 switch and effectively couple the signal from a resistor voltage divider to the Schmitt trigger circuit.

Schmitt Trigger

The emitter-coupled logic (ECL) triple line receiver, IC4, forms a Schmitt trigger to speed up the rise and fall time of the low-frequency signals in order to properly drive the ECL to low-power Schottky level converters, Q5 and Q6.

Amplifier and ÷10 Circuit (10-520 MHz)

The PRESCALE PC board contains a hybrid UHF band amplifier (IC304) that is matched into a 50-ohm input impedance. The output of this amplifier drives a high-speed, ECL divide-by-ten counter (IC301) that drives a low-power Schottky gate (IC302) which is selectively turned on or off by the PRESCALE function.

Steering Circuit

Directs the signals required for each of the three functions. The 5 Hz-60 MHz input is directed to the CC GATE in the FREQ function and the 10-520 MHz input is directed to the CC GATE in the PRESCALE function. If the PERIOD function is selected, the 10 MHz time base signal is directed to the CC GATE and the 5 Hz-60 MHz input is steered to the "P" input of IC11.

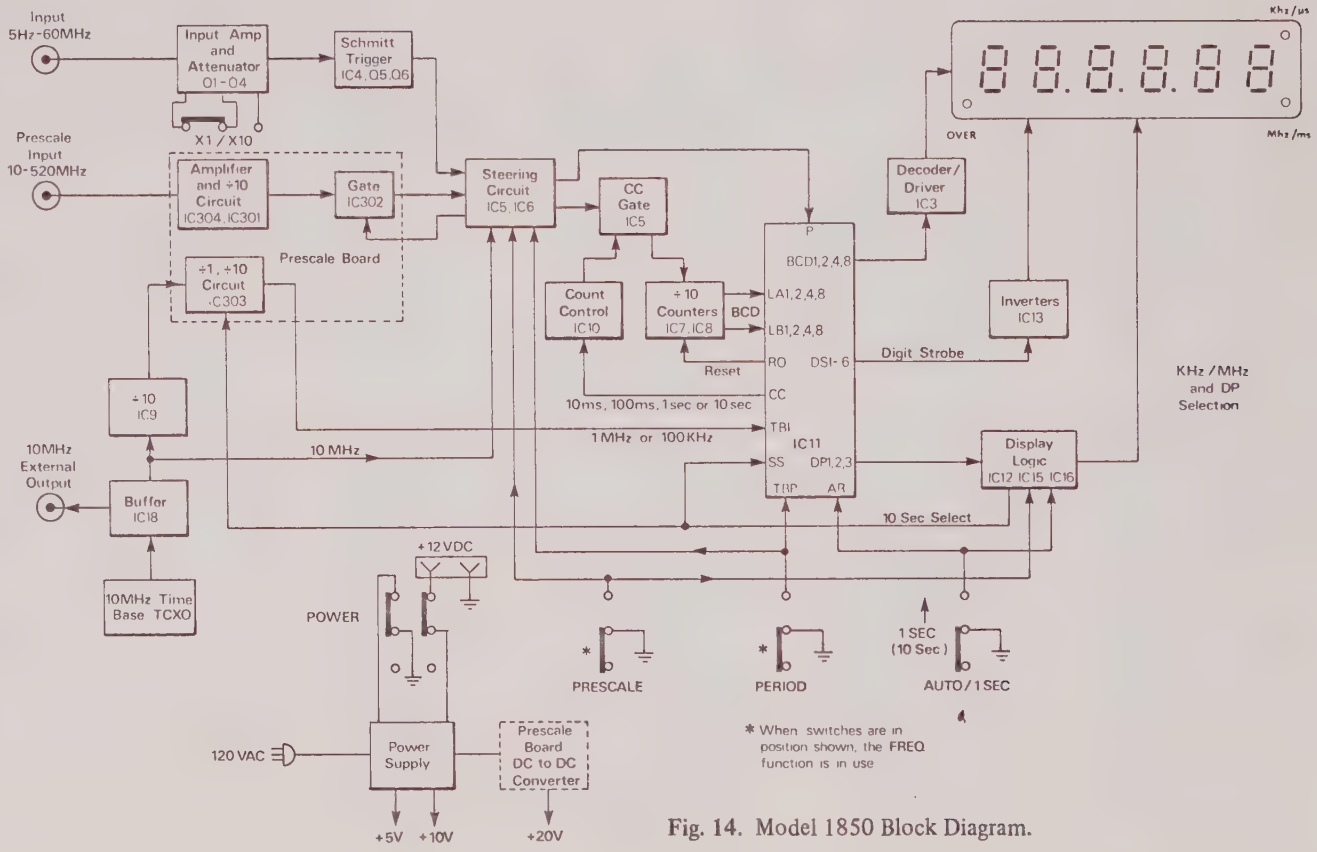


Fig. 14. Model 1850 Block Diagram.

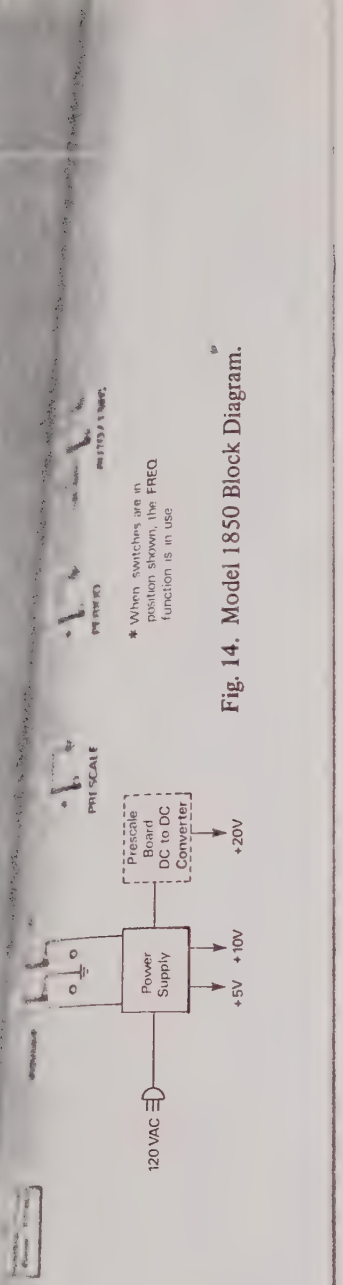

* When switches are in position shown, the FREQ function is in use
Prescale Board DC to DC Converter
+20V
Power Supply
+5V +10V
120 VAC

Fig. 14. Model 1850 Block Diagram.

Counter Circuit

IC7 and IC8 are divide-by-ten counters that produce a BCD coded output into IC11. The custom LS1 chip, IC11, contains all the counting logic necessary for the function selected. The time base input (TBI)of IC11 is driven by a 1 MHz or 100 KHz signal. IC11 internally develops the strobe pulses, DS1-DS6, the count control (CC), reset out (RO), and decimal point select (DP1-DP3) required for the counting and display functions. The COUNT CONTROL, IC10, speeds up the CC rise and fall time and controls the CC GATE, IC5.

Display Section

The BCD 1, 2, 4, 8 and DS1-DS6 outputs of IC11 are multiplexed. The BCD outputs are decoded by IC3 into seven-segment outputs that sink, in parallel, the display digits. DS1-DS6 are strobed outputs that are inverted by IC13 and turn on the displays in proper sequence. The DISPLAY LOGIC, IC12, IC15, IC16, turns on the appropriate decimal point and KHz/μS-MHz/mS indicator as needed for the function selected.

TXCO Time Base

The 10 MHz TCXO time base is a very accurate oscillator with a frequency stability of ±1 PPM over temperature range 0° - 50°C. IC18 buffers the signal to drive the various internal circuits and the 10 MHz EXTERNAL OUTPUT jack, which is provided for user convenience. The divide-by-ten circuit, IC9, provides the 1 MHz signal required for the TBI of IC11. Note that the prescale PCB contains a ÷1, ÷10 CIRCUIT, IC303, which will again divide-by-ten the time base signal for the 10-second mode only.

Power Supply

The Model 1850 can be powered by either 120 VAC or 12 VDC (negative ground). The main PCB uses an IC regulator for the +5 supply voltage and a zener diode for the +10 V supply. The prescale board has its own DC-to-DC converter to obtain the +20 V supply needed to operate the hybrid amplifier, IC304.

RECALIBRATION AND MAINTENANCE
(Refer to Fig. 15 and 16)

Your model 1850 counter was carefully checked and calibrated at the factory prior to shipment. If recalibration or maintenance should ever be required, follow the instructions provided.

There is only one adjustment in this instrument, the TCXO frequency adjustment. Calibration of this instrument is exceptionally simple when the proper equipment is available; it should not be attempted unless you are experienced and qualified in the use of precision laboratory equipment. Should any difficulty occur during repair or calibration, refer to the warranty service instruction at the rear of this manual for information or technical assistance.

The TCXO time base is located at the right rear of the counter on the main printed circuit board. A seal screw is provided on the TCXO, and must be removed to calibrate it. See "B" below for case removal. Be careful not to lose the rubber seal or the screw.

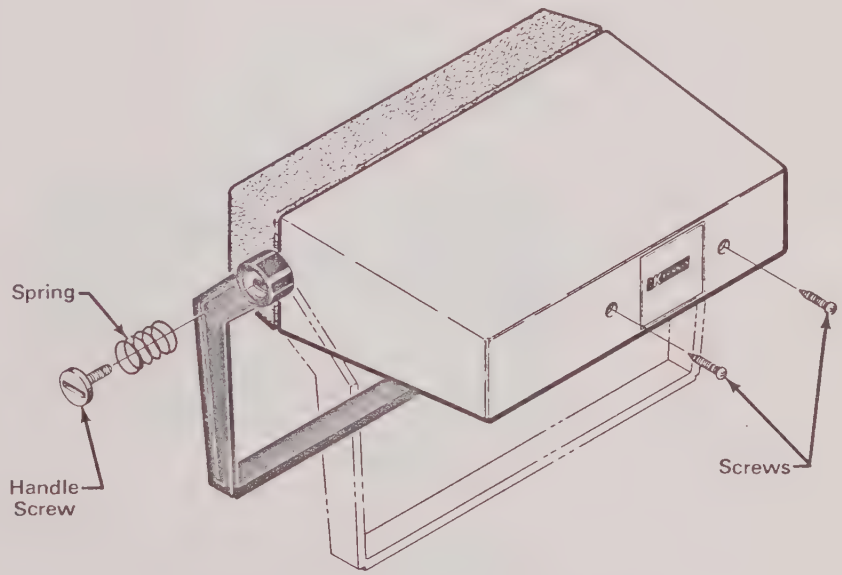


Fig. 15. Removal of Rear Case from Model 1850.

A. To calibrate the oscillator, a 10 MHz standard with accuracy of at least ±1 part in 10^8 is required to set the oscillator to within ±1 Hz at 10 MHz.
Procedure:

1. Depress POWER switch.

2. Connect the standard frequency source to front panel input (5 Hz-60 MHz).

3. Depress the FREQ and AUTO/1 SEC switches.

NOTE

The instrument will overrange and thus the MSD will be lost.

4. With a non-metallic alignment tool, adjust through hole in TCXO shield for a display equal to the standard frequency ±1 count. The displayed count will be 999.999, 000.000 or 000.001. The 000.000 count is preferred.

5. Replace seal screw and re-assemble the rear case.

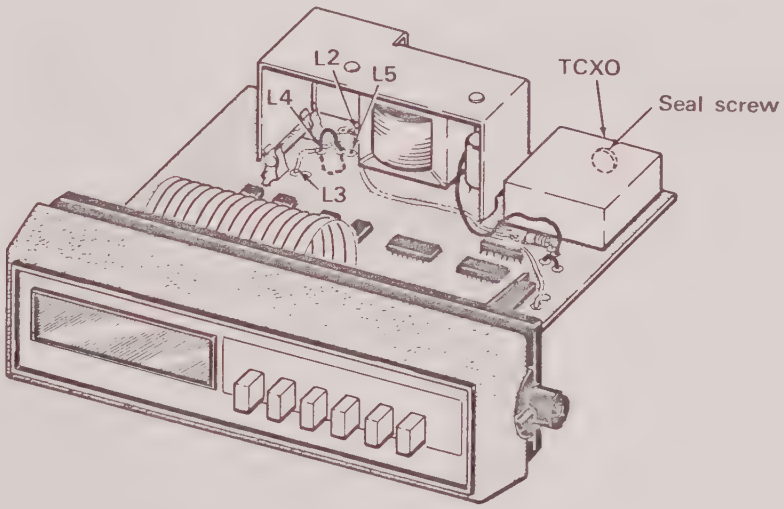
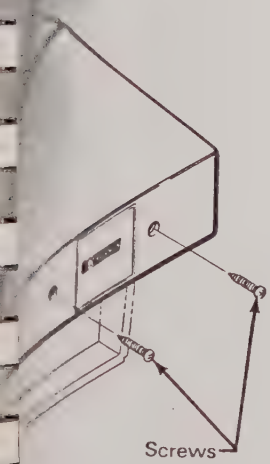


Fig. 16. TCXO Calibration.

...at the factory
...required, follow

...TCXO frequency
...when the proper
...experienced and
...difficulty occur
...at the rear of

...counter on the main
...must be removed
...to lose the rubber



...del 1850.

B. To remove the rear case from the counter, proceed as follows:

1. Use a coin (a quarter works best) to remove the two screws that hold the handle to the case. Use caution to avoid losing the springs beneath the screws that hold the handle on the case. Remove handle.

2. Remove the two Phillips-head screws from the rear case.

3. Slide the rear case from the counter.

4. To re-install the rear case on the counter, follow the above procedure in reverse. When re-installing the rear case, be sure the printed circuit boards properly engage the slots inside the case

C. Basic trouble-shooting check-list.

Should your 1850 not operate, be sure to make the following basic checks before assuming there is a defective component, etc.:

1. Is unit plugged into a "live" AC outlet, or proper DC cigarette lighter socket.

2. Is the unit turned ON (POWER switch depressed)?

3. Is the fuse OK? (If blown, replace with same type fuse.)

4. The DC cord has a fuse (1A, 3 AG slo-blo) that is removed by pushing in the center pin of the cigarette lighter plug and rotating counterclockwise until the gap in the flutes on the pin align with the notch in the plastic and then pull firmly to remove.

5. Is line cord OK?

APPENDIX

A. DAMPING RESISTOR CALCULATION (Refer to Fig. 17 and 18)

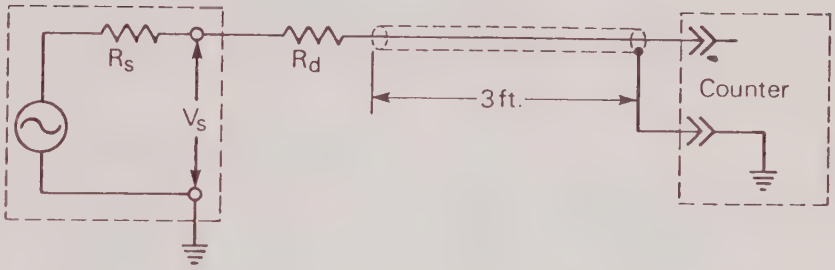


Fig. 17. Use of Damping Resistor When Performing Frequency Measurements.

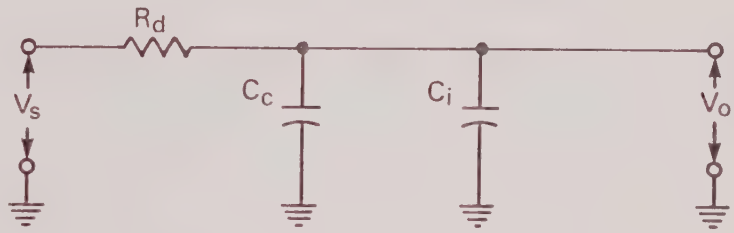


Fig. 18. Equivalent Circuit.

Fig. 17 illustrates the use of a damping resistor when performing frequency measurements. As shown in Fig. 18 the cable capacitance, C_c, and the counter input capacitance, C_i, form a voltage divider when a damping resistor, R_d, is added in series. In order for the damping resistor to have the optimum damping effect on ringing and overshoot, the value of R_d must be calculated. In order to calculate the value of R_d, the signal amplitude and frequency must be known. However, the frequency is usually unknown before the frequency measurement. Therefore, only the approximate value of R_d can be determined by estimating the source frequency. To maintain a minimum voltage of 30 mV RMS at the counter input (V_o), calculate the value of R_d using the following formula:

$$R_d = \frac{V_s - V_o}{V_o} \quad X_c \quad \text{where}$$

(a) $X_c = \frac{1}{2\pi f_1 C}$ = capacitor impedance at frequency f_1

(b) $C = C_c + C_i$; where

C_c = 87 pF (typical for three feet of RG-58/U coaxial cable);
and C_i = 20 pF (typical);
and V_o = 30 mV RMS (counter sensitivity);
and V_s = signal amplitude at the source, in volts;
and f_1 = the estimated square wave or pulse train repetition frequency.
Choose a lower value for R_d if the duty cycle is low.

B. FREQUENCY PERIOD TABLES

The tables in this section of the APPENDIX provide listings of standard audio frequencies in common use in the electronics industry. In each Table the frequency and the period are given. Frequency is the reciprocal of period. When using a calculator, divide the period reading into 1 to get frequency.

NOTE: 1 mSEC = .001 SEC and 1 μSEC = .000001 SEC.

1. **Telephone Touch-Tones.** Each of the pushbuttons on a telephone touch-tone pad activates a pair of frequencies. These tones are used to activate the telephone terminal equipment. The digits on a telephone touch-tone pad and their respective frequency pairs are listed in Table I.

DIGIT (SYMBOL)	FREQUENCIES (PERIODS)
1	697 Hz (1434.72 μS) 1209 Hz (827.130 μS)
2	697 Hz (1434.72 μS) 1336 Hz (748.503 μS)
3	697 Hz (1434.72 μS) 1477 Hz (677.948 μS)
4	770 Hz (1298.70 μS) 1209 Hz (827.130 μS)
5	770 Hz (1298.70 μS) 1336 Hz (748.503 μS)
6	770 Hz (1298.70 μS) 1477 Hz (677.048 μS)
7	852 Hz (1173.71 μS) 1209 Hz (827.130 μS)
8	852 Hz (1173.71 μS) 1336 Hz (748.503 μS)
9	852 Hz (1173.71 μS) 1477 Hz (677.048 μS)
0	941 Hz (1062.69 μS) 1336 Hz (748.503 μS)
*	941 Hz (1062.69 μS) 1209 Hz (827.130 μS)
#	941 Hz (1062.69 μS) 1477 Hz (677.048 μS)

Table I. Telephone touch-tone pad digits and frequency pairs.

2. **Modem Frequencies.** There are two sets of standard audio frequencies used for data communications:

   a. U.S. Standards

   b. The Consultative Committee on International Telephone and Telegraph (CCITT).

   These frequencies, their periods and corresponding bit pairs are listed in Table II.

U.S. STANDARD FREQUENCY (PERIOD)	BIT PAIR	CCITT FREQUENCY (PERIOD)
1270 Hz (787.402 μS)	00	980 Hz (1020.41 μS)
1070 Hz (934.579 μS)	01	1180 Hz (847.458 μS)
2225 Hz 449.438 μS)	10	1650 Hz (606.061 μS)
2025 Hz (493.827 μS)	11	1850 Hz (540.540 μS)

Table II. Modem frequencies.

3. **American Scale of Equal Temperament (Table III).** This scale is included as a source of reference information for the frequency and period of musical notes. This table will be useful when the counter is being used to tune electronic musical instruments.

NOTE/FREQ.	C_{00}/16.351 Hz	$C^{\#}_{00}$/17.324 Hz	D_{00}/18.354 Hz	$D^{\#}_{00}$/19.445 Hz	E_{00}/20.602 Hz	F_{00}/21.826 Hz	$F^{\#}_{00}$/23.125 Hz	G_{00}/24.499 Hz	$G^{\#}_{00}$/25.956 Hz	A_{00}/27.500 Hz	$A^{\#}_{00}$/29.135 Hz	B_{00}/30.867 Hz
PERIOD	61.1583 mS	57.7234 mS	54.4840 mS	51.4271 mS	48.5390 mS	45.8169 mS	43.2432 mS	40.8179 mS	38.5267 mS	36.3636 mS	34.3230 mS	32.3971 mS
NOTE/FREQ.	C_{0}/32.703 Hz	$C^{\#}_{0}$/34.647 Hz	D_{0}/36.708 Hz	$D^{\#}_{0}$/38.890 Hz	E_{0}/41.203 Hz	F_{0}/43.653 Hz	$F^{\#}_{0}$/46.249 Hz	G_{0}/48.999 Hz	$G^{\#}_{0}$/51.913 Hz	A_{0}/55.000 Hz	$A^{\#}_{0}$/58.270 Hz	B_{0}/61.735 Hz
PERIOD	30.5782 mS	28.8625 mS	27.2420 mS	25.7136 mS	24.2701 mS	22.9709 mS	21.6221 mS	20.4086 mS	19.2630 mS	18.1818 mS	17.1615 mS	16.1983 mS
NOTE/FREQ.	C_{1}/65.406 Hz	$C^{\#}_{1}$/69.295 Hz	$D^{\flat}_{1}$/73.416 Hz	$D^{\#}_{1}$/77.781 Hz	E_{1}/82.406 Hz	F_{1}/87.307 Hz	$F^{\#}_{1}$/92.498 Hz	G_{1}/97.998 Hz	$G^{\#}_{1}$/103.826 Hz	A_{1}/110.00 Hz	$A^{\flat}_{1}$/116.540 Hz	B_{1}/123.470 Hz
PERIOD	15.2891 mS	14.4310 mS	13.6210 mS	12.8566 mS	12.1350 mS	11.4538 mS	10.8110 mS	10.2053 mS	9631.50 μS	9090.91 μS	8580.74 μS	8099.13 μS
NOTE/FREQ.	C_{2}/130.812 Hz	$C^{\#}_{2}$/138.591 Hz	D_{2}/146.832 Hz	$D^{\flat}_{2}$/155.563 Hz	E_{2}/164.813 Hz	F_{2}/174.614 Hz	$F^{\#}_{2}$/184.997 Hz	G_{2}/195.997 Hz	$G^{\#}_{2}$/207.652 Hz	A_{2}/220.000 Hz	$A^{\flat}_{2}$/233.081 Hz	B_{2}/246.941 Hz
PERIOD	7644.56 μS	7215.48 μS	6810.50 μS	6428.36 μS	6067.48 μS	5726.92 μS	5405.49 μS	5102.12 μS	4815.75 μS	4545.45 μS	4290.35 μS	4049.55 μS
NOTE/FREQ.	C_{3}/261.625 Hz	$C^{\#}_{3}$/277.183 Hz	D_{3}/293.664 Hz	$D^{\flat}_{3}$/311.126 Hz	E_{3}/329.627 Hz	F_{3}/349.228 Hz	$F^{\#}_{3}$/369.994 Hz	G_{3}/391.995 Hz	$G^{\#}_{3}$/415.304 Hz	A_{3}/440.000 Hz	$A^{\flat}_{3}$/466.163 Hz	B_{3}/493.883 Hz
PERIOD	3822.26 μS	3607.72 μS	3405.25 μS	3214.13 μS	3033.73 μS	2863.45 μS	2702.75 μS	2551.05 μS	2407.87 μS	2272.72 μS	2145.17 μS	2024.77 μS
NOTE/FREQ.	C_{4}/523.251 Hz	$C^{\#}_{4}$/554.365 Hz	D_{4}/587.329 Hz	$D^{\flat}_{4}$/622.253 Hz	E_{4}/659.255 Hz	F_{4}/698.456 Hz	$F^{\#}_{4}$/739.988 Hz	G_{4}/783.991 Hz	$G^{\#}_{4}$/830.609 Hz	A_{4}/880.000 Hz	$A^{\flat}_{4}$/932.327 Hz	B_{4}/987.766 Hz
PERIOD	1911.13 μS	1803.86 μS	1702.62 μS	1607.06 μS	1516.86 μS	1431.73 μS	1351.35 μS	1275.52 μS	1203.94 μS	1136.36 μS	1072.59 μS	1012.39 μS
NOTE/FREQ.	C_{5}/1046.502 Hz	$C^{\#}_{5}$/1108.730 Hz	D_{5}/1174.659 Hz	$D^{\flat}_{5}$/1244.507 Hz	E_{5}/1318.510 Hz	F_{5}/1396.912 Hz	$F^{\#}_{5}$/1479.976 Hz	G_{5}/1567.982 Hz	$G^{\#}_{5}$/1661.218 Hz	A_{5}/1760.000 Hz	$A^{\flat}_{5}$/1864.654 Hz	B_{5}/1975.532 Hz
PERIOD	955.564 μS	901.933 μS	851.311 μS	803.531 μS	758.432 μS	715.865 μS	675.687 μS	637.762 μS	601.968 μS	568.182 μS	536.293 μS	506.193 μS
NOTE/FREQ.	C_{6}/2093.004 Hz	$C^{\#}_{6}$/2217.460 Hz	$D^{\flat}_{6}$/2349.318 Hz	$D^{\flat}_{6}$/2489.014 Hz	E_{6}/2637.020 Hz	F_{6}/2793.824 Hz	$F^{\#}_{6}$/2959.952 Hz	G_{6}/3135.964 Hz	$G^{\flat}_{6}$/3322.436 Hz	A_{6}/3520.00 Hz	$A^{\flat}_{6}$/3729.308 Hz	B_{6}/3951.064 Hz
PERIOD	477.782 μS	450.966 μS	425.655 μS	401.766 μS	379.216 μS	357.932 μS	337.843 μS	318.881 μS	300.984 μS	284.091 μS	268.146 μS	253.096 μS
NOTE/FREQ.	C_{7}/4186.008 Hz	$C^{\#}_{7}$/4434.920 Hz	D_{7}/4699.636 Hz	$D^{\flat}_{7}$/4978.028 Hz	E_{7}/5274.040 Hz	F_{7}/5587.648 Hz	$F^{\#}_{7}$/5919.904 Hz	G_{7}/6271.928 Hz	$G^{\flat}_{7}$/6664.812 Hz	A_{7}/7040.000 Hz	$A^{\flat}_{7}$/7458.616 Hz	B_{7}/7902.128 Hz
PERIOD	238.891 μS	225.483 μS	212.782 μS	200.883 μS	189.608 μS	178.966 μS	168.922 μS	159.441 μS	150.483 μS	142.046 μS	134.073 μS	126.548 μS

Table III. American Scale of Equal Temperament.

4. **Continuous Tone-Controlled Squelch System Frequencies (CTCSS).** The CTCSS code frequencies are used to code two-way radio communications on shared channels. Two code groups are used and are shown in Table IV.

GROUP A		GROUP B	
FREQUENCY (Hz)	PERIOD	FREQUENCY (Hz)	PERIOD
67.0	14.9254 mS	71.9	13.9081 mS
77.0	12.9870 mS	87.5	12.1212 mS
88.5	11.2994 mS	94.8	10.5485 mS
100.00	10.0000 mS	103.5	9661.84 μS
107.2	9328.36 μS	110.9	9017.13 μS
114.8	8710.80 μS	118.8	8417.51 μS
123.0	8130.08 μS	127.3	7855.46 μS
131.8	7587.25 μS	136.5	7326.01 μS
141.3	7077.14 μS	146.2	6839.95 μS
151.4	6605.02 μS	156.7	6381.62 μS
162.2	6165.23 μS	167.9	5955.93 μS
173.8	5753.74 μS	179.9	5558.64 μS
186.2	5370.57 μS	192.8	5186.72 μS
203.5	4914.00 μS	210.7	4746.08 μS
233.6	4280.82 μS	241.8	4135.65 μS
250.3	3995.21 μS		

Table IV. Continuous tone-controlled squelch system frequencies (CTCSS).

5. **Miscellaneous Frequencies Encountered.** See Table V.

USE/FUNCTION	FREQUENCY	PERIOD
TV horizontal	15734.26 Hz	63.556 μS
Stereo FM pilot carrier	19,000 Hz	52.631 μS
Test tone	400 Hz	2500.00 μS
Power line frequencies	60 Hz	16.6667 μS
	50 Hz	20.0000 μS
Kansas City standard cassette interface		
"Space"	1200 Hz	833.333 μS
"Mark"	2400 Hz	416.667 μS
16x Clock	4800 Hz	208.333 μS
Amateur RTTY		
"Mark"	2125 Hz	470.588 μS
170 Hz Shift "Space"	2295 Hz	435.730 μS
850 Hz Shift "Space"	2975 Hz	336.134 μS
Amateur slow-scan TV		
Sync	1200 Hz	833.333 μS
Black	1500 Hz	666.667 μS
White	2300 Hz	434.783 μS

Table V. Miscellaneous frequencies encountered.

C. 240-VOLT LINE OPERATION

The Model 1850 is factory-wires for use with 120V, 50/60 Hz AC lines. To operate the unit on 240V, 50/60 Hz, the internal connections must be changed. To convert the 1850 for 240 VAC operation, proceed as follows:

1. Remove the rear case of the counter as described in par. B of the RECALIBRATION AND MAINTENANCE section of this manual.

2. Remove the jumper wire connecting holes L3 and L4 on the printed circuit board.

3. Remove the jumper wire connecting holes L2 and L5 on the p. c. board.

4. Connect a jumper wire between holes L4 and L5 on the p. c. board. This jumper may be placed on the component side or the bottom side of the circuit board: L4 and L5 are adjacent to each other.

5. Remove the 3/16-ampere Type 3AG slo-blo fuse from the fuseholder at F1. Replace with 1/10-ampere Type 3AG slo-blo fuse.

6. Make a notation of the change near the fuse label on the transformer bracket.

7. Re-assemble the rear case of the counter as described in Par. B of the RECALIBRATION AND MAINTENANCE section of this manual.

8. The wires within the detachable line cord are color-coded according to the European DIN standard. Connect the proper plug to match your outlet after the U.S.-style plug has been removed.

WARRANTY SERVICE INSTRUCTIONS

1. Refer to the MAINTENANCE section of your B & K-Precision instruction manual for adjustments that may be applicable.

2. Defective parts removed from units which are within the One Year Limited Warranty period should be sent PREPAID to the Service Department listed below. Be sure to state the model and serial number of the unit from which the parts were removed and date the unit was purchased. These parts will be exchanged at no charge, under the terms of the Warranty.

3. If the above-mentioned procedures do not correct the problem you are experiencing with your unit, pack it securely (preferably in the original carton or double-packed). Enclose a letter describing the problem and include your name and address. Deliver to, or ship PREPAID (UPS preferred) to the nearest B & K-Precision authorized service agency (see list enclosed with unit).

If your list of authorized B & K-Precision service agencies has been misplaced, contact your local distributor for the name of your nearest service agency, or write to:

Service Department

B & K-Precision Product Group
DYNASCAN CORPORATION
2815 West Irving Park Road
Chicago, Illinois 60618

LIMITED ONE-YEAR WARRANTY

DYNASCAN CORPORATION warrants to the original purchaser that its B & K-PRECISION product, and the component parts thereof, will be free from defects in workmanship and materials for a period of one year from the date of purchase.

DYNASCAN will, without charge, repair or replace, at its option, defective product or component parts upon delivery to an authorized B & K-PRECISION service contractor or the factory service department, accompanied by proof of the date of purchase in the form of a sales receipt.

To obtain warranty coverage, this product must be registered by completing and mailing the enclosed warranty registration card to DYNASCAN, B & K-PRECISION, P.O. Box 35080, Chicago, Illinois 60635 within five (5 days) from the date of purchase.

Exclusions: This warranty does not apply in the event of misuse or abuse of the product or as a result of unauthorized alterations or repairs. It is void if the serial number is altered, defaced or removed.

DYNASCAN shall not be liable for any consequential damages, including without limitation damages resulting from loss of use. Some states do not allow limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This warranty gives you specific rights and you may also have other rights which vary from state to state.

For your convenience we suggest you contact your B & K-PRECISION distributor, who may be authorized to make repairs or can refer you to the nearest service contractor. If warranty service cannot be obtained locally, please send the unit to B & K-PRECISION Service Department, 2815 West Irving Park Road, Chicago, Illinois 60618, properly packaged to avoid damage in shipment.